ADDITIONS TO VESPINE BIOLOGY. I. NOTES ON MATING AND BROOD REARING.

By Albro T. Gaul, Brooklyn, N. Y.

The experiments and observations recorded in this paper were all made in Brooklyn, N. Y., during the summer of 1941. The hornets were all collected out of town (1), and were transported with the nests in screen covered cans.

The maintenance of the colonies in the city involved more care than the method of housing in window hives, previously described (2). The wasps had to be prevented from trespassing in neighboring homes and giving grievous cause for complaint. Also, they had to have a degree of freedom for normal exercise and for feeding. They had to be available for observation at all times.

A cage was constructed in the backyard. It enclosed a space of 128 cubic feet and was built of 1/8 mesh wire screening. One end of the cage comprised a 2 by 2 foot screen door for access, and a set of three hives similar to the window hives previously mentioned. The hives were movable and could be taken into the laboratory. The captured nests were placed in these hives. Grass and wild plants were grown in the cage.

The size of the cage permitted limited flight on the part of the hornets and it afforded an opportunity for the control of feeding.

The depredations of the ant, *Monomorium pharaonis* Lin., caused a considerable brood mortality. Otherwise the colonies fared rather well in confinement.

The hornets were fed by placing melon rinds, honey, sugar, suet and meat scraps in the cage. A supply of tap water was available to the wasps in a shallow pan of wet sand.

Mating.

On August 4, 1941, at 2:55 P.M. (E.D.S.T.) mating was first observed on *Dolichovespula arenaria* Fab. This is probably the first record of any observed Vespine mating. It is of extreme interest that the male and the queen were both from the same colony, there was only one nest of this species in the cage. The mating may best be described chronologically:

2:55 P.M.—Male and queen discovered during nuptial antics. Queen is walking about in the cage. Male is standing, fore legs holding queen's tegulae, mid legs holding her wings and hind legs grasping her fourth abdominal tergite. Antennae of male are briskly stroking queen's pronotum and antennae. Male genitalia are ejected.

3:01 P.M.—Queen walks into a group of males resting on the screening. Males interfere, whereupon queen's mate leaves her to chase intruders. He immediately returns to his original position with his queen.

3:25 P.M.—Queen has been walking about with the male all this time. Male now changes his position: he drops back until his head is in line with the queen's first abdominal segment, forelegs clutching her wings, mid legs holding her hind femora and hind legs grasping her hind tibiae. Now the queen cannot walk, her mid and hind tarsi twitch nervously. Her antennae are quiet.

3:32 P.M.—The pair are still motionless and unmated. Male is flexing his claspers.

3:36 P.M.—Male extends abdomen and grasps tip of queen's adbomen with his claspers. His abdomen is flexed to the right about 20 degrees. The male genitalia are thrust toward the queen's abdomen from the right side. The apparent copulation lasts but a few moments.

3:40 P.M.—Genitalia are no longer in contact. The male telescopes his abdomen from time to time. Queen is quiet.

3:55 P.M.—The male taps the cage with his genitalia.

3:57 P.M.—Male resumes position first described at 2:55 P.M. Queen again walks about with her mate.

6:20 P.M.—Male and queen part company for the first time since 3:01 P.M. After walking alone for a few paces the male returns to the queen. His genitalia are still extruded.

7:13 P.M.—Male has been walking about and returns to the queen only occasionally. The queen now objects to his advances.

7:45 A.M. (Aug. 5, 1941)—Male (who was marked at 7:13 P.M., Aug. 4.) is now lying dead in the cage. Queen (who was also marked) is alive and active. Control males, who did not mate, are also active.

That the mating was probably successful was indicated by the contact of the genitalia and by the subsequent death of the male, although his genitalia were still intact.

It must be kept in mind that the conditions were atypical, and that the cage prevented a true nuptial flight. The fact that the male grasped the queen's wings and thus prevented a flight attempt, may be explained on the grounds that during a true nuptial flight he would overtake her in the air, that her wings would already be in motion and consequently that he could not grasp them. It is highly improbable that Vespine mating could go so long unrecorded if it

took place on or near the ground. The encounter with the other males is also an abnormal contingency.

It must be remarked that no other wasps were observed in an attempted mating.

Rau (3) has suspected that males and females of *Polistes* from the same nest will mate. Here, however, is a definite record of an attempted mating, and possibly a successful mating, of two Vespines from the same nest.

Egg Deposition.

It has been previously reported (4) that the queen hornet places one egg in each cell, and attached to that angle of the hexagon which is nearest the center of the comb. The author has never observed any deviation from this habit.

The workers on the other hand lay their eggs at any position in the cell (5). Often as many as six or eight eggs may be placed in one cell by the workers. This leads to the general appearance of confusion and disorganized oviposition instincts on the part of the workers.

It must be recalled that whereas one queen lays eggs, many workers can lay eggs. A careful worker egg count in a number of combs of several species reveals a very definite pattern of worker egg deposition. Notes were taken on the relative position, depth in the cell, and approximate age of each worker egg in nests of *Vespula maculifrons* Buysson, *Dolichovespula maculata* Lin. and *D. arenaria* Fabricius. Many adjacent cells in a comb have an egg of the same age, at the same relative position and at the same depth. Series of cells have the same worker egg pattern. This consistent phenomenon seems to overrule the laws of chance and probability.

Since the worker is a female, we cannot expect her to have instincts at great variance with the queen, the normal female. We could hardly expect a worker to deposit more than one egg in each cell of a comb. We should certainly expect the worker to develop a habit of oviposition, as the queen has developed her particular habit.

The author's explanation for the worker egg pattern is in complete agreement with what we might expect, as well as with the direct evidence: A number of egg laying workers oviposit in a comb. Each worker places one egg in a cell. Each worker has her own habit of egg orientation in the cells.

The queen probably develops her habit of laying eggs at the inner angle of each cell, as that position will give the eggs most protection, and she in turn will be well balanced on a small comb when she

oviposits in that way. The workers, however, do not ovipost until the comb is fully developed, the colony stands a good chance for survival, the protection of their eggs is not essential and their position on the large comb is of little consequence; therefore they may oviposit in any way that they desire.

Brood Rearing.

It is interesting that the nurse workers will feed as many larvae in a cell as they can reach. One cell for instance, may have two second instar larvae and one third instar larva, all developed from workers eggs. This alone is ample proof that many larve may be fed in each cell.

Eventually, only one larva can survive in a cell; the surviving larva consuming his less fortunate brothers. The factors governing the survival of a larva are his depth in a cell and his age. The deeper larvae have a positional advantage when it comes to devouring their companions. The older larvae have the advantage of strength and firmer mandiles. Actually, the worker egg survey reveals that the deeper larvae are also the older; this may be a mechanical necessity of the function of oviposition in a cell.

What then, is the function of the younger and shallower placed larvae? When the workers lay eggs, the entire colony is on the decline. Workers may desert it at any time. If the deeper male larva has a supply of fat brothers in the same cell with him, his chances of ultimate survival are superior to a lone larva of the same age. The high male larva population in each cell at the end of the season may be a method of storing the cell with food for the one surviving larva, a deviation from a normal instinct among the solitary wasps.

Polistes wasps in our Northeastern states store a drop of nectar with each egg in a cell. Vespine wasps make no such provision for their young; they feed the larvae directly from the time of hatching.

Summary.

It has been found possible to maintain Vespine wasp colonies in complete captivity in cages. A successful mating has probably been observed between a male and a female from the same nest. Workers oviposit according to their individual habits, and many oviposit in the same cell. Workers will feed a number of larvae in the same cell. The survival of a larva in a cell containing many larvae depends upon position and age.

Literature Cited.

1. **Gaul, A. T.** A Method of Collecting Some Social Hymenoptera. Bull. Brooklyn Ent. Soc., Vol. XXXIV, pp. 197–8.
2. **Gaul, A. T.** Experiments in Housing Vespine Colonies, with Notes on the Homing and Toleration Instincts of Certain Species. Psyche, Vol. XLVIII, pp. 16–19.
3. **Rau, Phil.** At the End of the Season with Polistes Rubiginosus. Ent. News, Vol. XL, pp. 7–13.
4. **Duncan, C. D.** A Contribution to the Biology of North American Vespine Wasps. Stanford University Publications, Biological Sciences, Vol. VIII, No. 1, pp. 160.
5. **Duncan, C. D.** Ibid., pp. 161.

New Record for Notonecta borealis Bueno and Hussey:— This species was taken by Owen Bryant at Ft. Wrigley, N.W.T., on September 26, 1929. Ft. Wrigley is on the Mackenzie River, and represents the farthest north record of this species which has been reported from British Columbia and Quebec in Canada, and from Michigan, Minnesota, and Colorado in the United States.

H. B. Hungerford
Lawrence, Kans.